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FINAL REPORT

Contract Title: Computational Methods and Systems for Problems in Science and Engineering
Principal Investigator: Joseph Oliger
Contracting Institution: Stanford University, Stanford, CA
Funding Agency: Office of Naval Research
Contract Number: N00014-87-K-0384
Contract Period: 1 June 1987 through 31 May 1988

Summary of Accomplishments:

Our major objective in the work funded under this contract was to continue work begun under the ONR contract N0014-82-K-0335 related to adaptive grid methods for engineering problems in fluid dynamics and the development of parallel algorithms for the same class of problems. Some of this work has been completed under this contract and some of it is continuing under the ongoing ONR contract N00014-86-K-0565. This work is described below.

Adaptive Numerical Methods for Incompressible Flow

Tang and van der Wijngaart have completed work on the development and analysis of iterative methods for the solution of elliptic equations on adaptive grid structures. These are accelerated iterative methods and utilize Dirichlet conditions on inflow boundary segments and Neumann conditions on outflow boundary segments. These have proved to be efficient and have been implemented in an adaptive grid model by van der Wijngaart. Tang's work has been written up in his Ph. D. Thesis, Tang(1987), and presented in an invited lecture at the 1987 SIAM Meeting on Parallel Computation in Los Angeles. van der Wijngaart's work is being written up in his Ph. D. Thesis which will be completed in 1989.

Composite Grid Generation

We are extending our earlier work on adaptive grid methods to arbitrary geometries by using an underlying composite grid which carves up a complicated domain into a collection of regular pieces. Data structures and grid generation utilities for problems in two space dimensions have been designed and implemented in van der Wijngaart's thesis. A similar system has been designed for problems in three space dimensions by Venkata and will be implemented in his thesis

which is continuing under ONR contract N00014-86-K-0565.

Software Systems for Scientific Computation

We have designed two software systems, an editor and a preprocessor, for use with our composite grid generation system and to implement our composite adaptive grid method. The graphical editor VOUS enables one to visually define and edit grid structures and generate the appropriate data structures as directed graphs and to graphically represent our composite adaptive grid program which is to be written in the C preprocessor VORPAL inside of VOUS. VOUS allows us to represent our programs graphically and provides a very useful utility for modifying the composite adaptive grid system when moving from one application to another. It provides the user interface. The main features of VORPAL are the ability to easily work with complicated data structures in an abstract manner and to provide a capability for interactive control of processes so that one can run large scientific models interactively. VOUS has been described in the report by Oliger, Pitchumani and Ponceleón (1989). Pitchumani is continuing to work on VOUS and further work will be described in his thesis which will be completed in 1989. Suhr has done the design work for VORPAL and is implementing it and the composite adaptive grid system in it for his thesis which should be completed in 1990.

Algorithm Development for Parallel Computation

Worley has completed a project which analyzes algorithms for parallel computation which minimize required data sharing between processors in a distributed memory parallel machine. This work allows one to identify the simplest scalable architecture for a given problem whose solution is governed by partial differential equations. It also gives insight for the development of parallel algorithms. This work is described in Worley's Ph. D. Thesis (1988). Oliger is currently working on extensions of this work.

Books Published:

Joseph Oliger, Algorithm design for computational fluid dynamics on parallel machines, High Speed Computing, R. Wilhelmson ed., U. Of Ill. Press, 94-96 (1988).

Ph. D. Theses:

Patrick Worley, Information Requirements and the Implications for Parallel Computation, Stanford University, 1988.

Wei-Pai Tang, Schwarz Splitting and Template Operators, Stanford University, 1987.

Patents Filed:

None

Invited Conference Presentations:

Joseph Oliger, Adaptive Composite Grid Methods for Fluid Dynamics, SIAM Minisymposium on Methods for Compressible Fluid Computations, Denver, CO, 13 October 1987.

Wei-Pai Tang, Schwarz Splitting and Template Operators, SIAM Meeting on Parallel Computation, Los Angeles, CA December 1987.

Technical Reports:

Wei-Pai Tang, Schwarz splitting and template operators, CLaSSiC Report 87-3, Department of Computer Science, Stanford University, 1987.

Patrick Worley, Information Requirements and the Implications for Parallel Computation, Report STAN-CS-88-1212, Dept. of Computer Science, Stanford University, Stanford, CA (1989).

J. Oliger, R. Pitchumani and D. Ponceleón, A visual object-oriented unification system, CLaSSiC Project Manuscript CLaSSiC-89-23, Dept. of Computer Science, Stanford University, Stanford, CA (1989).

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